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FLEXIBLE POUCH, FILLING AND HEAT SEALING LINE FOR FLEXIBLE POUCHES, AND CONTAINERS FOR SUPPORTING AND MOVING THE FLEXIBLE POUCHES

FIELD OF THE INVENTION

This invention relates to a flexible pouch, filling and heat sealing line and associated apparatus for flexible pouches, and containers for supporting and moving the flexible pouches.

BACKGROUND ART

Flexible pouches which are generally referred to as doy pouches or pillow pouches comprise a front and back panel which are sealed along opposite edges. A gusset is arranged between the panels at the base of the pouch and the top of the pouch is heat sealed after the pouch is filled in a filling and heat sealing line.

In general, food products or other products which can deteriorate, are packaged in such pouches and it is therefore required that the pouches be properly sealed in order to provide sufficient shelf life for the product contained in the packages. If the product is not properly sealed, the product is likely to deteriorate in a very short time period, thereby spoiling the product. This generally makes the product unusable.

Such pouches are becoming increasingly more common and provide a convenient manner for storing and selling food products. However, these types of pouches do make handling more difficult in a plant in which the food product is packaged into the pouches. The reason for this is that the pouches are generally flexible in nature and do not stably stand on their own. Thus, the transportation of the pouches after the pouches have been filled and sealed throughout the plant for further processing and packaging is difficult.

SUMMARY OF THE INVENTION

A first invention is concerned with a pouch which facilitates easy visual inspection of the pouch by a vision system to ensure the integrity of the sealed pouch, and so that pouches which are not properly sealed can therefore be rejected.

This invention may be said to reside in a flexible pouch comprising:

a front panel;

a rear panel;

the front and rear panels being joined along opposite side edges;

a closed base;

an open end opposite the base through which a product can be loaded and which is to be closed by a seal which joins the front and rear panels together; and

a transparent region in at least one of the front and rear panels which overlaps the region of the front and rear panels at which the seal is to be formed to facilitate inspection of the seal to determine the integrity of the heat seal.

The transparent region increases the ease by which a vision system can inspect the seal to determine the integrity of the seal or determine if the seal is faulty. The transparent strip more easily allows light to be transmitted through the front and rear panels in the vicinity of the seal so that that light can then be detected to determine the integrity of the seal.

Preferably, a translucent filter of constant colour is provided on one of the panels so the seal, when formed, is between the translucent filter and the said at least one of the front and rear panels, so if the seal is properly formed, a substantially uniform intensity of light will be transmitted through the filter. Thus, if the seal is not properly formed and food particles or other contaminants are located in the seal thereby destroying the integrity of the seal, the amount of

illumination transmitted through the filter is not constant, thereby enabling "dark spots" to be detected to provide an indication that the seal is not properly formed, and therefore to allow the pouch to be rejected.

Preferably, the transparent region is provided adjacent a top edge of the front panel of the pouch.

Preferably, the transparent region includes a fluorescing material which fluoresces when subjected to light of a particular wavelength to produce white light, and wherein when the front and rear panels are sealed together, the transparent region and the adjacent portion of the other of the front or rear panel forms a continuous waveguide for transmission of white light so that any failure of the seal where the panels do not seal will allow light to disperse, thereby breaking the integrity of the waveguide so that those regions are identifiable by inspection of the said adjacent portion.

Preferably, the said adjacent portion is translucent to define a filter which can be detected by a camera so that dark regions indicative of an improperly formed seal can be identified.

Preferably, the fluorescing material fluoresces when subjected to ultraviolet light.

Preferably, the ultraviolet light has a wave length of from 320 to 350 nm.

Preferably, the closed base is defined by a gusset at the base of the pouch connected to the front and rear panels for closing the base of the pouch.

A second invention is concerned with a container for receiving sealed pouches to enable the pouches to be manoeuvred through a processing system after the pouches have been filled and sealed.

This invention may be said to reside in a container for receiving and supporting flexible pouches, comprising:

a container body having an open top and an open bottom so water can drain through the open top, over the

pouches supported in the container and out through the open bottom;

a plurality of support elements, each for supporting side edges of the pouch;

first cooperating locator means on an upper portion of the container body;

second cooperating locator means on a lower portion of the container body; and

wherein two like said containers are able to be stacked one above the other by the first cooperating locator means of one container engaging the second cooperating locator means of the other container.

The container of the invention enables the pouches to be held within the container for transport around the plant for further processing and also enables the containers to be stacked one above the other so that a number of the containers can be moved together on a pallet for further processing.

Preferably, the support elements each comprise a pair of spaced apart slots for receiving the side edges of the pouch, each slot having a guide entrance formed by a pair of inclined surfaces which incline outwardly from the slot and downwardly toward the slot to form a guide for guiding the edges of the pouch into the slots.

This feature enables pouches to be dropped from above the container and for the side edges of the pouches to be easily and conveniently guided into the slots so that the slots support the pouch.

Preferably, the container includes two rows of opposed slots so that the pouches are supported in pairs in the container.

Preferably, the first cooperating locator means comprises at least one a tapered pin, and the second cooperating locator means comprises at least one hole.

Preferably, the container body includes opposed side walls and opposed end walls, and a first said tapered pin is provided on a block fixed to an upper portion of

one of the side walls, and a second said tapered pin is provided on a block fixed to an upper portion of the other side wall diametrically opposite the first pin.

Preferably, the container body includes a flange extending at least partway along each side wall, one of said flanges having a first said hole in vertical alignment with the first pin, and the other said flange having a second said hole in vertical alignment with the second said pin.

Preferably, the flanges extend along the entire length of the side walls.

Preferably, the slots are provided in rails which extend between the opposite ends of the container body.

Preferably, the open bottom of the container body comprises a plate, the said flanges being integral with, and part of, the plate, and at least one aperture in the plate for forming the open bottom.

Preferably, the plate includes a plurality of rectangular apertures for forming the open bottom of the container.

In one embodiment of the invention the container is formed from a plurality of container modules, each module having a pair of said support elements, and connector elements for connecting the modules together to form the container.

Preferably the connector elements comprise at least one bore passing through each module so that modules can be located in side-by-side relationship with the bores forming a channel through the modules, and a rod for location in the aligned channel to connect the modules together.

Preferably the modules include two bores extending substantially at right angles with respect to one another so that when the modules are located together to form the container, pins are extended through the respective channels formed by the bores so that the pins connect the modules together in both a first direction of

the container and a second direction perpendicular to the first direction.

Preferably the pins include at least one screw threaded end for receiving a nut.

The pins may have an opposite end which includes a screw threaded end for receiving a nut or a pin head to thereby locate the rods in the aligned channels.

A third invention relates to a pallet for supporting the containers so that a number of containers can be stacked on the pallet and the pallet can be moved through the processing plant for further processing of the product contained within the pouches which are supported in the containers. This invention also enables the containers to be properly located on the pallet and stably supported so that once a pallet is positioned, the position of the containers on the pallet can be determined to enable the containers to be lifted by a robot.

This aspect of the invention may be said to reside in a pallet for receiving a plurality of containers for receiving pouches containing a product, including:

a pallet body; and

a plurality of locator elements on the pallet body for registering with cooperating locator elements on the containers so that when the containers are loaded onto the pallet, the cooperating locator elements on the containers engage the locator elements on the pallet to securely support and locate a first layer of the containers on the pallet.

This aspect enables a number of containers to be securely loaded and accurately located on the pallet, and for the containers to be stacked one above the other in layers so that the pallets can be manoeuvred through the processing plant on the pallets and accurately located for engagement by a robot.

Preferably, the pallet includes handle receiving elements for receiving a handle to facilitate movement of the pallets after loading the pallets onto a trolley.

Preferably, the cooperating locator elements comprise tapered pins which project upwardly from the pallet body.

Preferably, the pallet body has a lower surface, the lower surface having a plurality of grooves for registering with conveyor elements to enable the pallet to be moved on a conveyor.

Preferably, the pallet body is formed from longitudinally extending and transversely extending frame elements, a plurality of beams being formed on an upper surface of the frame elements, and the tapered pin being provided on the beams.

A further invention is concerned with the manner in which the pouches are moved through the plant after packaging of a product in the pouches and sealing of the pouches.

This invention may be said to reside in a packaging system plant, including:

a filling and heat sealing line for filling pouches with a product and sealing the filled pouches;

a container for receiving filled and sealed pouches from the line, and for supporting a plurality of the pouches;

a transporter for receiving the containers loaded with the pouches to form a stack of the containers, and for enabling the stack of containers to be moved from one place to another;

an ancillary processing station for receiving the containers transported by the transporter and for performing an ancillary treatment step on the filled pouches while housed in the stack of containers; and

a packaging station for receiving the transporter carrying the stack of containers to enable the pouches to be removed from the containers and packaged for distribution.

According to this invention, the packages are retained in the containers as the packages are moved from

the filling and heat sealing line and transported about the plant for further processing to the packaging station. This enables convenient and easy manoeuvrability of the pouches to other treatment stages within the plant, and for those treatment stages to take place while the pouches are properly supported. Thus, handling and movement of the pouches is much easier throughout the plant between filling and packaging for distribution.

Preferably, the ancillary treatment stage comprises a retort for receiving the pouches.

Preferably, the retort is a shower type retort.

In another embodiment, the ancillary treatment stage comprises a cooling station for cooling heated pouches. In this embodiment, there may also be provided the drying station for drying the pouches.

The retort provides hot water to the packages which is able to be sprayed and flow through the containers to heat and pasteurise and/or cook the food product within the pouches whilst the pouches are supported in the containers.

Preferably, the system includes a disperser plate for location on the stacked containers, the disperser plate having a plurality of holes so that hot water flows onto the disperser plate and through the plurality of holes, and then passes down through the containers and over the pouches to treat the pouches.

Preferably, the system includes stacking means for stacking the containers on the transporter after the containers have been loaded with the pouches.

Preferably, the stacking means comprises a robot for engaging a loaded container and moving the loaded container from a loading station to the transporter.

Preferably, the container includes a container body having an open top and an open bottom so water can drain through the open top, over the pouches supported in the container and out through the open bottom;

a plurality of support elements, each for

supporting side edges of the pouch;

first cooperating locator means on an upper portion of the container body;

second cooperating locator means on a lower portion of the container body; and

wherein two like said containers are able to be stacked one above the other by the first cooperating locator means of one container engaging the second cooperating locator means of the other container.

Preferably, the support elements each comprise a pair of spaced apart slots for receiving the side edges of the pouch, each slot having a guide entrance formed by a pair of inclined surfaces which incline outwardly from the slot and downwardly toward the slot to form a guide for guiding the edges of the pouch into the slots.

This feature enables pouches to be dropped from above the container and for the side edges of the pouches to be easily and conveniently guided into the slots so that the slots support the pouch.

Preferably, the container includes two rows of opposed slots so that the pouches are supported in pairs in the container.

Preferably, the first cooperating locator means comprises at least one a tapered pin, and the second cooperating locator means comprises at least one hole.

Preferably, the container body includes opposed side walls and opposed end walls, and a first said tapered pin is provided on a block fixed to an upper portion of one of the side walls, and a second said tapered pin is provided on a block fixed to an upper portion of the other side wall diametrically opposite the first pin.

Preferably, the container body includes a flange extending at least partway along each side wall, one of said flanges having a first said hole in vertical alignment with the first pin, and the other said flange having a second said hole in vertical alignment with the second said pin.

Preferably, the flanges extend along the entire length of the side walls.

Preferably, the slots are provided in rails which extend between the opposite ends of the container body.

Preferably, the open bottom of the container body comprises a plate, the said flanges being integral with, and part of, the plate, and at least one aperture in the plate for forming the open bottom.

Preferably, the plate includes a plurality of rectangular apertures for forming the open bottom of the container.

Preferably, the transporter comprises a pallet.

Preferably, the pallet includes a pallet body; and

a plurality of locator elements on the pallet body for registering with cooperating locator elements on the containers so that when the containers are loaded onto the pallet, the cooperating locator elements on the containers engage the locator elements on the pallet to securely support and locate a first layer of the containers on the pallet.

Preferably, the pallet includes handle receiving elements for receiving a handle to facilitate movement of the pallets after loading the pallets onto a trolley.

Preferably, the cooperating locator elements comprise tapered pins which project upwardly from the pallet body.

Preferably, the pallet body has a lower surface, the lower surface having a plurality of grooves for registering with conveyor elements to enable the pallet to be moved on a conveyor.

Preferably, the pallet body is formed from longitudinally extending and transversely extending frame elements, a plurality of beams being formed on an upper surface of the frame elements, and the tapered pin being provided on the beams.

In another embodiment, the transporter comprises

a continuous conveyor for conveying stacked containers to the ancillary processing station.

Preferably, the conveyor passes through the ancillary processing station and then to the packaging station.

The container may be a continuous conveyor or a plurality of separate conveyors with indexing mechanisms for moving containers from one of the conveyors to another of the separate conveyors.

This invention may be said to reside in a method of manoeuvring pouches in a packaging plant, comprising:

filling pouches with a product and sealing the filled pouches;

loading filled and sealed pouches into containers so the pouches are supported in the containers;

stacking the containers loaded with the pouches on a transporter;

moving the stacked containers on the transporter to an ancillary processing station for performing an ancillary treatment step on the filled pouches while housed in the stack of containers; and

moving the stacked containers on the transporter to a packaging station to enable the pouches to be removed from the containers and packaged for distribution.

Preferably, the ancillary treatment stage comprises a retort for receiving the pouches.

Preferably, the retort is a shower type retort.

Preferably, the method includes locating a disperser plate on the stacked containers, the disperser plate having a plurality of holes so that in the retort hot water flows onto the disperser plate and through the plurality of holes, and then passes down through the containers and over the pouches to treat the pouches.

In another embodiment, the ancillary treatment stage is a cooling station for cooling heated pouches.

In one embodiment, the transporter comprises a pallet upon which the containers are stacked and which

pallet is moved to the ancillary processing station, and then to the packaging station.

In another embodiment, the transporter comprises at least one conveyor for conveying the stacked containers to the ancillary processing station, and then to the packaging station.

A further invention relates to a container handling system for supplying containers so that pouches can be loaded into containers, and then loading the containers onto a pallet so that a plurality of loaded containers can be moved about a processing plant.

This invention may be said to reside in a system for handling containers which are to be loaded with pouches to facilitate movement of the pouches through a processing plant, including:

a carriage for receiving an empty container;

first carriage moving means for moving the carriage from a container receiving position to a first container release position and returning the carriage to the container receiving position;

loading means for loading the container into the carriage when the carriage is in the container receiving position;

indexing means for receiving the container from the carriage at the release position and for indexing the container past a loading station at which filled and sealed pouches are loaded into the container as the container is indexed past the loading station;

a second carriage for receiving loaded containers from the indexing means;

second carriage moving means for moving the second carriage from a loaded container receiving position to a second container release position; and

unloading means for moving the loaded container from the second carriage at the second release position and stacking the loaded container on a pallet.

Preferably, the first carriage has first clamping

means for clamping the container when loaded into the first carriage so that the container is moved with the carriage as the carriage is moved from the receiving position to the release position, and which is disengaged from the container at the first release position to enable the container to drop onto the indexing means.

Preferably, the indexing means comprises a continuous loop carrying a plurality of abutment elements for engaging the container and indexing the container as the continuous loop is indexed.

Preferably, the continuous loop comprises a pair of continuous chains driven by a motor and sprocket assembly.

Preferably, the abutment members comprise a plurality of bars which extend between the continuous chains and define receiving spaces for receiving the container so that the container is engaged by one of the bars and indexed with the continuous chains and bars.

Preferably, the indexing means includes guide means for receiving a container so that the container can slide on the guides as the container is indexed by the indexing means.

Preferably, the system includes lifting means at the loaded container receiving position so that the container is lifted from the indexing means into a position for engagement by the second carriage.

Preferably, the second carriage includes second clamping means for engaging the container when received by the second carriage so that the container can be moved by the second carriage to the second release position.

Preferably, the loading means and the unloading means comprise a robot for performing both the loading of the empty containers into the first carriage and the unloading of filled containers from the second carriage.

Preferably, the carriages have sensors for detecting when a container is received in the first and second carriages.

Preferably, the system further includes a pallet moving conveyor for moving a pallet, from which the empty container is removed, to a stacking location, at which a filled container is deposited by the unloading means.

Preferably, the system further includes a supply conveyor for supplying pallets loaded with empty containers to the empty container unloading station, and a discharge conveyor for receiving pallets stacked with loaded containers and for transporting the stacked pallet to a discharge station.

Preferably, the pallet moving conveyor extends between the supply conveyor and the discharge conveyor, and includes a first lifting means for lifting the empty pallet above the supply conveyor so the empty pallet can be conveyed by the pallet conveyor to the stacking station, and lowering means at the stacking station for lowering the pallet onto the discharge conveyor.

A further invention is concerned with the movement of pallets, from an unloading station at which empty containers are removed from the pallet, to a stacking station and which loaded containers are stacked on the pallets.

This invention may be said to reside in a pallet handling apparatus for receiving pallets stacked with containers, from which the containers are to be unloaded, so the containers can be loaded with pouches, and then stacked on an empty pallet, said apparatus comprising:

a supply conveyor for conveying pallets stacked with containers to a container unloading station so the containers can be unloaded at the unloading station and supplied to a pouch loading station at which pouches are loaded into the containers;

a discharge conveyor for conveying pallets from a stacking station upon which loaded containers are stacked on a pallet, to a pallet discharge station;

a pallet moving conveyor extending between the unloading station and the stacking station for conveying

an empty pallet from the unloading station to the stacking station;

first pallet transfer means at the unloading station for transferring a pallet from the supply conveyor at the unloading station onto the pallet moving conveyor; and

second conveyor transfer means at the stacking station for transferring the pallet from the moving conveyor onto the discharge conveyor.

Thus, pallets are able to be moved to an unloading station where the pallets are unloaded and then the empty pallet is moved to a stacking station so the pallet can be stacked with containers which are filled with pouches. The stacked pallet can then be moved to a discharge station for discharge of the pallet and stacked containers so the pallet and containers can then be moved to further processing stations where further treatment of the filled pouches is to take place. This further treatment may include supply of the pouches to a retort and then packaging of the pouches in boxes.

Preferably, the supply conveyor includes a plurality of chain conveyor section.

Preferably, the discharge conveyor includes at least one chain conveyor which extends from the stacking station towards the discharge station, and a discharge roller conveyor at the discharge station.

Preferably, the pallet moving conveyor includes an intermediate chain conveyor section and the first transfer means comprises a first roller conveyor at the unloading station, lifting means for raising the first roller conveyor relative to the at least one supply chain conveyor so that lifting of the first roller conveyor engages the pallet and lifts the pallet above the at least one supply chain conveyor so the pallets can then move on the first roller conveyor and onto the intermediate chain conveyor, a second roller conveyor at the stacking station, lowering means connected to the second roller

conveyor for lowering the second roller conveyor to lower the pallet onto the at least one discharge chain conveyor section.

Preferably, the first raising means comprises a ram and guide assembly for moving the first roller conveyor in a vertical direction between a raised and lowered position.

Preferably, the second moving means comprises at least one ram and guide assembly for moving the second roller conveyor in a vertical direction between a raised and lowered position.

Preferably, the intermediate chain conveyor includes at least one drive sprocket and a motor for driving the sprocket, and therefore the chain conveyor.

Preferably, the first and second roller conveyors have a first drive motor and a second drive motor respectively for driving at least one of the rollers of each of the first and second roller conveyors.

Preferably, the plurality of chain conveyor sections each includes a drive sprocket and at least one motor for driving each conveyor chain section.

Preferably, the discharge chain conveyor section includes a sprocket and at least one motor for driving the discharge chain conveyor section.

Preferably, the discharge roller conveyor includes idler rollers so that the pallet can be rolled manually or under the influence of gravity on the first roller conveyor.

Preferably, a pallet trolley is provided for supplying pallets stacked with empty containers to the supply conveyor and for receiving pallets stacked with loaded containers from the discharge conveyor, the trolley including an upper roller conveyor section including a plurality of rollers so that pallets can be rolled off the trolley onto the supply conveyor and off the discharge conveyor onto the trolley, locking means for locking the pallet to the trolley so the trolley can then be moved to

transport the pallet and the containers from one place to another.

Preferably, a trolley support is provided at a supply end of the supply conveyor and at a discharge station of the discharge conveyor, the support comprising a pair of guide channels for receiving the wheels of the trolley, and allowing the trolley to be registered with the supply conveyor or the discharge conveyor, wheel locking means for locking the trolley to the trolley support to hold the trolley stationary relative to the supply conveyor or discharge conveyor to enable the pallet to be moved from the trolley onto the supply conveyor or off the discharge conveyor onto the trolley.

Preferably, the locking means comprises a spring biased catch which is engaged by the pallet as the pallet is moved onto the trolley, and moved against the bias of the spring to locate behind a portion of the pallet to lock the pallet to the trolley.

Preferably, the locking means includes a lever for pivotal movement to move the catch out of engagement with the portion of the pallet so the pallet can be released from the trolley.

Preferably, the supply conveyor includes a chain conveyor section which forms the unloading station, the chain conveyor section having a pair of chains and means for circulating the chains about a continuous loop so a pallet can be moved on the section, and wherein the first pallet transfer means includes a subassembly mounted to the chain conveyor section, the subassembly carrying a first roller conveyor formed of a plurality of rollers, means for raising and lowering the subassembly and first roller conveyor relative to the chain conveyor section so that when a pallet is on the chain conveyor section at the unloading station, the subassembly can be raised to engage the pallet and lift the pallet above the chains of the chain conveyor section so the pallet can then be moved on the first roller conveyor in a direction transverse to the

direction of movement on the chain conveyor section, and wherein the moving means is for lowering the subassembly so the roller conveyor is moved below the chains of the chain conveyor section to allow another pallet to move along the chain conveyor section; and

the discharge conveyor including a discharge conveyor chain section which defines the stacking station, the discharge chain conveyor section including a pair of chains for moving a pallet on the discharge chain conveyor section, a second subassembly mounted to the discharge chain conveyor section, and including a second roller conveyor, second moving means for raising the second subassembly and the second roller conveyor relative to the discharge chain conveyor section so that in a raised position of the subassembly and the second roller conveyor, the pallet is able to move along the pallet moving conveyor and onto the second roller conveyor, the second moving means also being for lowering the second roller conveyor to deposit the pallet on the chains of the discharge chain conveyor section; and

the first subassembly, the first roller conveyor and the second subassembly and the second roller conveyor forming part of said pallet moving conveyor so that a pallet can be rolled from the first conveyor section along the pallet moving conveyor to the second roller conveyor.

Preferably, the supply conveyor chain section includes abutments for receiving a pallet to locate the pallet on the supply conveyor chain section so the pallet is accurately located at the unloading station.

Preferably, holding means are provided on the supply conveyor chain section for engaging the pallet and holding the pallet at the unloading station.

Preferably, second holding means are provided at the discharge chain conveyor section for releasably holding the pallet at the stacking station.

Preferably, a container indexing means is provided for indexing containers past a loading station at

which pouches are loaded into the containers;

container loading and unloading means for unloading an empty container from a pallet at the unloading station and depositing the container on the indexing means for indexing past the pouch loading station; and

collecting a loaded container and depositing the loaded container onto a pallet at the stacking station.

A further invention concerns monitoring the integrity of a seal of a pouch to determine whether the seal has been properly formed, and therefore whether the pouch should or should not be rejected.

This invention may be said to reside in a filling and heat sealing line for filling pouches with product, comprising:

a filling station for loading a product into the pouches;

a heat sealing station for heat sealing filled pouches;

moving means for moving the pouches from the filling station to the heat sealing station;

a vision system;

pouch moving means for moving pouches from the heat sealing station past the vision system;

said vision system including:

(a) a light source for producing light so that light is transmitted through a transparent region on one side of the sealed pouch which overlaps a heat seal produced by the heat sealing station;

(b) at least one camera for receiving light transmitted through the seal;

(c) processing means for determining from the light received by the camera the integrity of the seal to determine whether the pouch should or should not be rejected.

Thus, as the pouches are filled and heat sealed, the pouches can then be monitored to determine the

integrity of the seal, and if the seal is not properly formed, the pouch can be rejected before the pouch is moved for further processing and packaging into boxes.

Preferably, the pouch includes a transparent strip which overlaps the heat seal to facilitate transmission of light through the region of the pouch in the vicinity of the heat seal to in turn facilitate determination of whether the seal has been properly formed.

Preferably, the processing means compares the light received by the cameras with a grey scale to provide an indication of whether the seal is properly formed.

Preferably, the system includes a reject station which is activated by the processing means if a seal is determined to be inadequate so the pouch is rejected from the line at the reject station.

Preferably, the reject station comprises a moveable door over which the pouches pass and which is open to enable the pouches to drop through the door.

Preferably, the processing means is for determining whether pixels of the at least one camera see light intensity on a grey scale above a predetermined grey scale value, and also determines whether a second predetermined number of adjacent pixels have a grey scale value above that predetermined number, and if so, produce the signal indicative of the seal not being properly formed so that the pouch can be rejected at the reject station.

Preferably, the pouch is provided with notches and the processing means identifies the notches to in turn use the identified notches as a point of reference for determining the inspection region defined by the transparent strip which is positioned at a known location with respect to the notches.

This invention also provides a seal integrity monitoring system for inspecting the integrity of a seal in a pouch which has a transparent region on one side of

the pouch, a translucent region on the other side of the pouch, and a seal formed between the transparent region and the translucent region, comprising:

a light source for producing radiation and directing the radiation through the transparent region;

a camera for viewing the translucent region and for producing an image of the translucent region; and

a processor for processing the image captured by the camera to determine the integrity of the seal.

Preferably the seal is a heat seal and the transparent region comprises a transparent region in a first panel of the pouch and the translucent region is a translucent coating on a second panel of the pouch which is connected to the first panel by the seal, the first panel including a fluorescing material at least in the vicinity of the transparent region, so that when the light source directs the light through the transparent region, the fluorescing material fluoresces to produce white light, and if the first and second panels are properly sealed together, a continuous waveguide is provided for transmission of the white light to the translucent coating, and if the seal is not properly formed, a continuous waveguide is not formed, thereby allowing light to disperse where the seal is not properly formed so those parts of the seal appear as a dark region on the translucent region.

Preferably the light source is an ultraviolet light source for producing ultraviolet light of a wavelength from 320 to 350 nanometers.

Preferably the camera comprises a CCD array type camera.

Preferably the processor processes the images captured by the camera by determining pixels which have a grey value above a predetermined value, thereby providing the indication of an improperly formed part of the seal.

Preferably the processor determines that the seal is satisfactory if a band of a predetermined thickness of

properly formed seal can be defined from one side of the pouch to the other side of the pouch.

This invention also provides a seal integrity monitoring method for inspecting the integrity of a seal, the pouch having a first panel with a transparent region, a second panel having a translucent region on an outer surface of the second panel, and the seal being formed between the first and second panels at the transparent region and translucent region, the method comprising:

irradiating the translucent region so that the radiation passes into the translucent region, and if the seal is properly formed, the first and second panels at the seal form a continuous waveguide for directing radiation onto the translucent region, and if the seal is not properly formed, light is dispersed at the improperly formed seal, thereby producing a dark region at the translucent region;

detecting the translucent region with a camera to obtain an image of the translucent region; and

processing the image captured by the camera to identify any dark regions appearing at the translucent region to thereby determine the integrity of the seal.

Preferably the radiation has a wavelength of from 320 to 350 nanometers.

Preferably the camera is a CCD array camera and the processing step determines the grey scale value of pixels of the CCD array in order to identify dark regions in the image.

Preferably the transparent region includes a fluorescing material so that when the light is directed to the transparent region, the fluorescent material fluoresces so that the fluorescing light then passes through the continuous waveguide to the translucent region, or if the seal is not in tact, is dispersed at the regions where the seal is not in tact so that dark regions are produced at the translucent region.

BRIEF DESCRIPTION OF THE DRAWINGS

A preferred embodiment of the invention will be described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a front view of a flexible pouch according to the preferred embodiment;

Figure 1A is a detailed view showing the structure of panels which make up the pouch according to the preferred embodiment;

Figure 1B is a view of part of the structure of Figure 1A;

Figure 1C is a side view of the top region of the pouch of Figure 1 in an open condition;

Figure 1D is a view similar to Figure 1C of the pouch properly sealed;

Figure 1E is a view similar to Figure 1D but of an improper seal;

Figure 1F is a view of the pouch of Figure 1 from the back, showing a properly-formed seal as it would be inspected by a vision system for determining the integrity of the seal;

Figure 1G is an example of an improperly-formed seal;

Figure 1H is a view of an improperly-formed seal;

Figure 1I is a view of a seal including some contaminant regions;

Figure 2 is a plan view of a container according to the preferred embodiment;

Figure 3 is an underneath view of the container of Figure 2;

Figure 4 is a side view of the container of Figures 2 and 3;

Figure 5 is an end view of the container of Figures 2 and 3;

Figure 6 is an end view showing flexible pouches loaded into the container;

Figure 7 is a view similar to Figure 6, but

showing a different sized pouch;

Figure 8 is a view of a tray used in the embodiment of Figure 6;

Figure 9 is a perspective view of the container of Figures 2 and 3;

Figure 10 is an enlarged detailed view of part of the container of Figure 2 and 3;

Figure 11 is a top perspective view of a pallet according to the preferred embodiment of the invention;

Figure 12 is an underneath view of the pallet of Figure 11;

Figure 13 is a plan view of containers, according to Figures 2 and 3, stacked on the pallet of Figures 11 and 12;

Figure 14 is a perspective view of a stacked pallet according to Figure 13;

Figure 14A is a perspective view of a container according to a further embodiment of the invention;

Figure 14B is an end view of the container of Figure 14A;

Figure 14C is a plan view of the container of Figure 14A;

Figure 14D is a side view of the container of Figure 14A;

Figure 14E is a cross-sectional view showing how modules are connected together to form the container of Figure 14A;

Figure 15 is a plan view of a filling and heat sealing line and pouch handling system according to the preferred embodiment of the invention;

Figure 15A is a plan view of a filling and heat sealing line according to another embodiment of the invention;

Figure 16 is a view of a trolley and support for loading and unloading pallets onto the system of Figure 15;

Figure 17 is a perspective view of the support

shown in Figure 16;

Figure 18 is a detailed view showing the support in an unlocked position;

Figure 19 is a view of the support in a locked position;

Figure 20 is a perspective view of a trolley shown in Figure 16;

Figure 21 is a view of part of the trolley of Figure 20 showing a locking mechanism;

Figure 22 is a perspective view of the locking mechanism of Figure 21;

Figure 23 is a plan view of part of the filling and heat sealing line shown in Figure 15;

Figure 24 is a side view of part of the filling and heat sealing line shown in Figure 15;

Figure 25 is a plan view of part of the mechanism shown in Figure 24;

Figure 25A is a cross sectional view along the line Z-Z of Figure 25 in a retracted position;

Figure 25B is a cross sectional view similar to Figure 25a but in an extended position;

Figure 26 is a side view of the mechanism shown in Figure 24;

Figure 27 is a plan view of an indexing mechanism shown in Figure 15;

Figure 28 is a plan view of the indexing mechanism of Figure 26 showing more detail;

Figure 29 is a side view of the mechanism of Figure 28, illustrating the movement of containers on the indexing mechanism;

Figure 30 is a cross sectional view along the line W-W of Figure 29;

Figure 31 is a cross sectional view similar to Figure 30 but in a second off loading position;

Figure 32 is a plan view showing additional detail of the indexing mechanism of Figure 28;

Figure 33 is a view similar to Figure 32 but in a

second operating position;

Figure 34 shows further detail of the opposite end of the indexing mechanism;

Figure 35 is a view similar to Figure 34 but in a second operating position;

Figure 36 is a cross sectional view along the line V-V of Figure 33;

Figure 37 is a detailed side view of the indexing mechanism;

Figure 38 is a detailed side view of the opposite end of the indexing mechanism;

Figure 39 is a diagram illustrating movement of a robot and its interaction with the indexing mechanism in stacking containers and removing containers from the indexing mechanism;

Figure 40 is an enlarged side view of a head of the robot of Figure 39;

Figure 41 is a view of the loading station 102 in a first operating position;

Figure 42 is a view of the loading station in a second operating position;

Figure 43 is a side view, as shown by the arrows X-X in Figure 15, of a supply conveyor used in the preferred embodiment;

Figures 44, 45 and 46 are a detailed view of the supply conveyor shown in Figure 43;

Figures 47 and 48 are diagrams showing the releasable retaining of a pallet on the supply conveyor;

Figure 49 is a view of part of the supply conveyor and the pallet moving conveyor in direction of line Y-Y in Figure 15;

Figure 50 is a view of the pallet moving conveyor taken from the line Y-Y of Figure 15;

Figure 51 is a view taken from the line Y-Y of part of the moving conveyor;

Figure 52 is a side view also along the line X-X of part of the discharge conveyor of Figure 15;

Figure 53 is a plan view of the part of the conveyor shown in Figure 33;

Figure 53A is a plan view of a stand-alone vision system according to an embodiment of the invention;

Figure 53B is a side view of the system of Figure 53A;

Figure 53C is an end view of the system of Figures 53A and 53B;

Figure 53D is a schematic view of pixels of a camera in a vision system for determining the integrity of a seal;

Figure 53E is a flow diagram describing operation of the vision system of the preferred embodiment of the invention; and

Figure 54 is a block diagram of a controller and sensor arrangement used in the preferred embodiment of the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

With reference to Figure 1, a front view of a flexible pouch, also called a doy pouch or pillow pouch, is shown. The pouch 1 has a front panel 3 and an opposite rear panel 5. The panels 3 and 5 are coupled together along the opposite edges 7 and 9 by heat sealing the panels together or by any other suitable method of connecting the panels 7 and 9 along their opposed edges. A gusset 11 is provided in the base of the pouch and is also joined to the front and back panels 3 and 5. The panels 3 and 5 and the gusset 11 may be formed from a single piece of material, or alternatively, can be formed from three separate pieces of material. The pouch 1 is closed by sealing the panels 3 and 5 together to form a seal 17. Preferably this is achieved by a heat sealing technique, but other sealing methods could be used. The above described pouch structure is known and therefore does not need to be defined in any further detail. In other embodiments, the gusset need not be provided and the

pouch could simply be formed from the panels 3 and 5.

As shown in Figure 1A, the material from which the pouch 1 is formed comprises a layer of PET 1a which forms an outermost surface of the pouch, a barrier layer 1b preferably formed from SiOx or AlOx, a strengthening layer 1c such as formed from OPA or nylon-like material, and a layer of polypropylene or polyethylene 1d which forms an innermost layer of the pouch. The PET layer provides good thermal properties for allowing the pouch to be subject to heat from heating bars of a heating sealing device (to be described later), the nylon or OPA layer provides good structural strength and the polypropylene or polyethylene provides a low melting point layer to enable the front 3 and rear 5 panels to be heat sealed together to form the seal 17 closing the pouch.

In another embodiment, rather than provide the PEN layer 1a'', the PET layer 1a may simply be a solid layer of PET and the fluorescing material may be provided by coating a UV absorbing layer or lacquer onto the inner surface of one of the layers which make up the panels 3 and 5, such as the inner surface of the barrier layer 1b.

The pouch may be provided in different sizes, and in particular, in different lengths, as illustrated by the dotted lines in Figure 1.

The PET layer 1a is shown in Figure 1B and comprises an extruded laminate of PET layers 1a' which sandwich a layer 1a'' of PEN (polyethylene naphthalate) which is a UV light absorbing material and which will fluoresce when subjected to a particulate wavelength UV light such as wavelengths from 200 nanometers to 400 nanometers, and most preferably from 320 to 350 nanometers.

The pouch 1 is printed to provide the getup of the pouch and also information including trade marks, product descriptions and other material which may be of aesthetic characteristic to provide the finished appearance of the pouch when the panels 3 and 5 are formed

and connected together to form the pouch 1. The printing is shown by reference numeral 1e in Figure 1A and Figure 1B, and is on the surface of the PET layer 1a which will be innermost when the panels 3 and 5 are connected to the pouch 1.

Typical dimensions of the layers which form the panels 3 and 5 are about 12 microns for the PET layer 1a, 0.4 microns for the barrier layer 1b, 25 microns for the strengthening layer 1c, and 110 microns for the polypropylene or polyethylene layer 1d.

The print layer 1e is simply a layer of print which may be applied by a suitable printing machine or device. As is most apparent from Figure 1A, the transparent strip 13 is made by ensuring that the print 1e on the panel 3 does not extend the entire length of the panel 3 and terminates short of the top of the panel where the heat seal 17 is to be formed. Thus, a transparent strip 13 through the panel 3 and then through the layers 1d, 1c and 1b of the panel 5 to the printed region 13a which is adjacent the strip 13 is provided. The layer 1a of the panel 5 is also transparent. Thus, the region of the sealed pouch 1 is transparent from the outer surface of the panel 5 all the way through the transparent strip 13 to the region 13a of the printed panel 5.

The printed layer 1e is provided on an inner surface of the layer 1a, rather than an outer surface of the layer 1a, to protect the print when the sealed pouch is subjected to further processing, such as in a retort, as will be described hereinafter. If the print is provided on the outer surface, the print may well be damaged in the further processing steps.

Thus, the pouch according to the preferred embodiment is provided with a transparent strip 13 adjacent top 15 which forms the opening to the pouch, and through which product is to be loaded into the pouch. The strip 13 overlaps seal region 17 which is to be formed when the pouch is filled and then passed through a heat

sealing unit, as will be described hereinafter. The seal 17 is positioned between the panel 3 and the region 13a so the pouch is transparent from the outer surface of panel 3 to the region 13a of the strip 13. In the embodiment shown, the strip 13 is arranged below upper edges 18 of the panels 3 and 5 which form the open top 15 prior to heat sealing of the panels 3 and 5. However, in other embodiments, the transparent strip 13 may extend all of the way up to the top edge 18.

As will be described in more detail hereinafter, to facilitate inspection of the seal, ultraviolet light is directed from the side on which the transparent strip 13 is provided so the light enters the transparent strip 13 to pass through the pouch. The panel 5 is provided with a translucent filter which is provided by at least the printed region 13a of the print layer 1e adjacent the strip 13. The filter region 13a is preferably of uniform colour to provide a uniform filter region adjacent the transparent strip 13. Most preferably, the colour of the print which forms the filter layer 13a is green, but other colours could also be used. In other words, whilst the print layer 1e may be multi-coloured in the remainder of the pouch 1, the part of the print layer 1e which forms the filter 13a is of a single colour which may simply be one of the colours which make up the remainder of the print layer 1e, but most preferably is green.

The transparent strip 13 may be provided simply by ensuring that the strip 13 at the panel 3 is not printed on when the pouch is printed. The strip 13 may be defined by a definite border where the printing terminates, or may simply be a blank region at the seal so that when exposed to the vision system, light is able to pass through the transparent panel 5 at the seal, through the panel 5 and through the filter 13a.

In the embodiment shown, a hole 20 is punched through the panels 3 and 5 above the transparent strip 13 so that the pouch can be hung from a hook or rail ready

for sale.

Notches 21 are cut into the side edges 7 and 9. The notices 21 are provided to enable the pouch 1 to be torn open when the contents of the pouch is to be used by a consumer.

The transparent strip 13 facilitates inspection of the sealed package by a vision system 98 (Figure 23) to determine whether the seal 17 is properly formed. Thus, the vision system will inspect the integrity of the seal 17 and if the seal is properly formed, the package can pass for further processing. If the seal is not properly formed, the pouch can be rejected, as will also be described hereinafter. The vision system therefore is able to inspect the seal 17 and determine whether any particular matter has become located in the seal 17 which will impair the integrity of the seal, and therefore result in spoiling of the product contained within the pouch 1, or produce an unpleasing appearance. The transparent seal 13 therefore facilitates visual inspection of the package by the vision system for monitoring the integrity of the seal 17.

The vision system generally comprises an ultraviolet light source 225 and a camera 230 (Figure 23), which will be described in more detail hereinafter. However, the manner in which the vision system operates will initially be explained with reference to Figures 1D to 1I. When the panels 3 and 5 are heat sealed in the manner to be described hereinafter, the panels 3 and 5 are joined at the seal. If the seal 17 is perfectly formed, as is intended to be illustrated in Figure 1D, the joined panels 3 and 5 at the seal 17 form a continuous waveguide (or light guide) so that ultraviolet light which is directed towards the transparent strip 13 in the direction of Arrow A passes through the transparent strip 13, thereby causing the fluorescent material within the layer 1a'' of layer 1a to fluoresce and create white light which continues in the uninterrupted waveguide through the panel

3, the seal 17, the panel 5 to the translucent filter 13a. The white light is filtered at the filter 13a because the screen 13a is of green colour and the wavelengths of the white light other than the green wavelengths are effectively absorbed by the filter 13a so that only the green light is transmitted through the filter 13a, and then through the layer 1a of the panel 5. The green light is not absorbed by the UV layer in the layer 1a because it is obviously of lower wavelength than ultraviolet light, and therefore is able to be detected by the camera of the vision system. The camera which is monitoring the translucent filter 13a is therefore able to see a bright uniform field on the filter 13a, as is shown in Figure 1F. The region outside the seal 17 is dark, because at those regions, the panels 3 and 5 are not joined together and therefore a continuous waveguide is not formed. Hence, light is able to scatter before reaching the translucent filter 13a, thereby producing a much darker image outside the seal 17, as illustrated by the regions marked 17a in Figure 1F.

Figure 1G is a view similar to Figure 1F, but shows a situation if the seal 17 is improperly formed because the pouch 1 has somehow become skewed in the machine and the seal 17 therefore does not extend right across the pouch, but rather is angled to leave a complete unsealed region 17b. The unsealed region is clearly shown because only the sealed part 17 forms a continuous light guide which appears as a very light region, and the remainder of the filter 13a is much darker, thereby indicating that no seal has actually been formed, because the panels 3 and 5 are not joined together to form a continuous waveguide.

Figure 1E shows an example of where an improperly formed seal 17 has resulted because some contaminant or the like has located itself in the seal region 17, thereby preventing the panels 3 and 5 from properly heat sealing together at the region 17d in Figure 1E. This may be

caused by a foreign particle or a particle of the product which is to be loaded into the pouch coming into contact with the interior surfaces of the panels 3 and 5 at the seal region 17, thereby preventing the seal from being properly formed. In this case, when the ultraviolet light is projected in the direction of Arrow A, the light will cause the fluorescing material to fluoresce to produce white light, as previously mentioned, and that white light will move through the pouch to the translucent filter 13a where the seal has been formed because of the continuity of the waveguide formed by the panels 3 and 5 at the seal 17. However, at the region 17d, the light will experience a change in refractive index causing a scattering or dispersion of the light because at that point, the waveguide is not continuous because of either an air gap or foreign matter material in the seal region 17. Thus, at the filter 13a, that area will appear as a much darker region than where the seal is properly formed and where the light is able to continue through the continuous waveguide formed by the properly joined panels 3 and 5.

Figure 1H shows what the vision system will see in the embodiment of Figure 1E, where the region 17d is a dark region compared to the properly sealed region 17. Small dark region 17d' may also be present, showing small pieces of foreign matter which have also prevented improper sealing of the panels 3 and 5.

A determination on whether the seal 17 is sufficient depends on the particular circumstances or regulations which may be in force in particular jurisdictions. For example, having regard to the nature of the product which is to be contained in the pouch 1, the seal 17 may be regarded as satisfactory provided that there is a continuous band of a predetermined width, say, 3 mm, from one edge 7 of the pouch to the other edge 9 of the pouch, notwithstanding the fact that small areas of improperly-formed seal (such as that shown in Figure 1I) may be present. In the case of Figure 1I, the band shown

by dotted lines and labelled 17' may form a continuous region across the width of the pouch, which is more than 3 mm thick, and which therefore may be regarded as a properly-formed seal, notwithstanding the fact that there are regions 17e which have not been properly sealed.

In the preferred embodiment of the invention, the region 17 is slightly narrower than the width of the filter 13a, and therefore the region which is inspected by the vision system so the top and bottom edges of the seal can be seen, thereby making it easier to identify the top and bottom of the seal, and therefore ensuring that an integral seal 17 is actually formed.

Figures 2 to 5 are views of a container for receiving and supporting a plurality of the pouches of the type described with reference to Figure 1. The container comprises a container body 25 formed from side walls 27 and 29, and end walls 31 and 33. As is shown in Figure 3, the bottom of the container 25 is provided with a base plate 35 which has a plurality of rectangular apertures 37 which form an open bottom. The top of the container 25 is open, as shown in the plan view of Figure 2, except for guide rails 39 and 41, so that water is able to flow down through the open top of the container 25, over the pouches supported in the container 25 and out through the apertures 37 in the base plate 35.

The base plate 35 extends beyond the side walls 29 to form flanges 43 which are part of and integral with the base plate 35.

A block 44 is connected in the top corner of the wall 29 and an identical block 45 is connected in the top diametrically opposite corner of the wall 27. The blocks 44 and 45 carry a tapered pin head 46 which form a first cooperating locating element for enabling a number of the containers to be stacked one above the other and locked in position relative to one another.

As best shown in Figures 3 and 9, the flanges 43 have circular holes 47 which are arranged directly below

the pins 46 and which form second cooperating locating elements for facilitating stacking of the containers 25.

As will be described in more detail hereinafter, two of the containers shown in Figures 2 to 5 can be stacked one above the other by locating one container above the other so that the pins 46 of a lower one of the containers are received in the holes 47 of the upper container. The engagement of the pins 46 in the holes 47 securely locate the containers together in a stable stack.

The rails 39 are connected to the walls 29 and 27 by screws 38 and extend along the walls 29 and 27 between the end walls 31 and 33. The rail 41 is arranged centrally between the rails 39 and also extends between the walls 31 and 33. The rail 41 is secured to the walls 31 and 33 by screws (not shown). As shown in Figures 4 and 5, the rails 39 and 41 are shorter than the height of the walls 27, 29, 31 and 33 and extend from the top of those walls only partway down the walls. One rail 39 and one side of the rail 41 are provided with aligned slots 50 for receiving the edges 7 and 9 of the pouches of Figure 1 so the pouches are supported in an upright position between the slots 50. The other rail 39 and the other side of the rail 41 are also provided with like lights 50 for receiving side edges 7 and 9 of pouches of the type shown in Figure 1. Thus, two rows R1 and R2 of slots 50 are provided so that two rows of pouches will be supported in the container so that the pouches are therefore arranged in pairs. Figure 9 shows the pouches 1 supported in the container 25 in pairs, which are identified by the reference numerals P1 and P2.

The slots are shown in more detail in Figure 10. As is best shown in Figure 10, each slot 50 has a slot entrance defined by a first surface 51 and a second surface 53 which taper outwardly with respect to one another from the slot 50, and which also slope or taper downwardly in a vertical direction. Thus, the surfaces 51 and 53 slope down towards the slot 50 so that when a pouch

1 is dropped from above a container 25, if the side edges 7 and 9 do not directly fall into the slots 50, the side edges will contact the sloping surfaces 51 or 53 and be guided into the slot 50 so that the side edges pass into the slot 50 until the bottom of the pouch 1 contacts base plate 35 of the container 25.

Figure 7 is a cross sectional view showing relatively long pouches 1 supported in the container 25 with the base of the pouches resting on base plate 35. If the pouches are shorter pouches, as shown in Figure 6, insert trays 55 are provided. The trays 55 are best shown in Figure 8 and comprise a generally U-shaped channel section having side flanges 57 and 59 and upper wall 60. The upper wall 60 is provided with apertures 61 which generally match the size and shape of the apertures 37 in the base plate 35. The trays 55 are located in the containers, as shown in Figure 6, to provide a platform on which the base of the shorter pouches 1', shown in Figure 6, can rest to ensure that edges 7 and 9 of the pouches are engaged in the slots 50 of the rails 39 and 43 so that pouches 1' are properly supported in the container 25.

Figures 11 and 12 show a pallet 62 upon which the containers 25 can be stacked. The pallet 62 comprises longitudinal frame members 63 and transverse frame members 65.

Four beams 67 are connected onto the frame member 63 and 65 and carry tapered pin heads 69, which are identical to the pin heads 46 previously described, and which are located so that when an initial layer of containers 25 is stacked on the pallet 62, two of the pins 69 will locate in the holes 47 in the flanges 43 of the containers 25 to securely locate the container 25 in position on the pallet 62. In the preferred embodiment of the invention, the pallet 62 is designed to carry an initial layer of 3 x 3 containers 25.

One of the end frame members 65 is provided with a pair of sleeves 71 which are intended to receive a

handle (not shown) which can be connected to the sleeves 71 and disconnected as desired, to provide a handle for enabling the pallet 62 to be manoeuvred when the pallet is loaded on a trolley (which will be described hereinafter).

As is shown in Figure 12, the underside of the pallet 62 is provided with grooves 73 which extend in a first direction, and grooves 75 which extend in a perpendicular direction for receiving chains of chain conveyors (which will be described hereinafter) for conveying the pallets on the chain conveyors from one place to another. The pallets 62 are conveyed by the chains simply by frictional contact of the chains in the grooves 73 or 75.

Figure 13 is a plan view of a loaded pallet on which the array of 3 x 3 containers 25 is clearly shown.

Figure 14 is a perspective view showing only one container 25 in full, with the remaining containers illustrated by dotted lines so their disposition relative to the pallet 62 can be clearly seen.

When the pallet 62 is stacked with loaded containers 25 containing pouches 1, a diffuser plate 77 can be located on the upper layer of containers 25. The diffuser plate 77 has a peripheral frame 79 and an upper surface 81 which is provided with a plurality of holes 85. The purpose of the diffuser plate 77 is to diffuse water which is provided in a retort, and which flows down through the containers 25 and over the pouches 1. The diffuser plate 77 diffuses and disperses the water so the water more gently trickles down through the containers and over the pouches 1 of the entire array of pouches provided in the stacked containers 25. This prevents direct spraying of water in the retort onto individual pouches which may soften those packages because of the heat of the water if a sufficient quantity of high pressure water is directed at a particular pouch. The diffuser plate 77 diffuses and disperses the water so that it more gently flows over the pouches, thereby reducing the flow rate of

the water so the water will not result in a high pressure being applied to various parts of particular pouches which may damage the pouches.

The peripheral frame 79 may be provided with openings 83 which are provided to register with pins 46 on the containers 25 in the uppermost layer of containers 25 stacked on the pallet 62 to securely locate the diffuser plate 77 in place on the stacked containers 25.

Figure 15 is a plan view of the filling and heat sealing line together with the pouch handling system according to the preferred embodiment of the invention. The filling and heat sealing line comprises a filling station 90, a heat sealing station 92, a cooling station 94, a pressing station 96, a vision system 98, a reject station 100 and a pouch loading station 102. The filling station, heat sealing station, cooling station and pressing station are all of conventional design and therefore will not be defined in any detail hereinafter. Suffice it to say that pouches are filled with a product at the station 90, the pouches are then sealed to form the heat seal 17, shown in Figure 1, at station 92, the heat seal region is cooled at station 94, and the pouches are then squeezed at station 96 so that the contents of the pouch is evenly distributed throughout the pouch.

The pouch is then passed through the vision system 98 where the pouches are monitored for seal integrity and if the seal is regarded as faulty, the pouches are ejected at reject station 100. If the pouches are properly sealed, they pass to pouch loading station 102 where the pouches drop into containers 25.

The system includes a supply conveyor 104 and a discharge conveyor 106. Pallets 62 are loaded onto the supply conveyor 104 and conveyed by the supply conveyor 104 from pallet receiving end 104′ to unloading station 104′′. The empty containers supported on pallet 62′ at the unloading station are unloaded from the pallet 62′ by robot 105. The robot 105 is conventional in design,

except for the head which engages the containers 25, and therefore will not be described in detail. The head of the robot will be described hereinafter. The robot 105 lifts a container from the pallet 62' and deposits the container in a container supply mechanism 106. The mechanism 106 will be described in detail hereinafter, and includes a indexing mechanism 108 which indexes the containers beneath the loading station 102 so that two pouches (P1, Figure 9) at a time are dropped from the loading station 102 into a pair of the aligned slots 50 in a container 25. The container 25 is then indexed to bring the next pair of slots into registry with the loading station 102 and another pair of pouches are then dropped into those slots. This continues until the container 25 has been indexed completely past the station 102 and is completely loaded with pouches 1. The robot 105 then grips the loaded containers 25 and stacks the containers 25 on an empty pallet 62a provided on the discharge conveyor 106.

When a pallet 62' at the unloading station 104'' has been fully unloaded and is empty, the pallet 62' is conveyed by a pallet moving conveyor 110 which passes beneath the robot 105 from the unloading station 104'' to a stacking station 106'' on the conveyor 106 and which is occupied by the pallet 62a shown in Figure 15. The moving conveyor 110 will be described in more detail hereinafter.

The robot 105 therefore stacks loaded containers 25 on the pallet 62a and when the pallet 62a is fully stacked, the pallet 62a is conveyed by the conveyor 106 to discharge end 106'.

The pallets are then collected by a trolley (which is shown in Figures 16 to 21) and the pallet 62 with the stack of loaded containers 25 is then pushed to retort 112 and the pallet and containers loaded with pouches is located in the retort 112 for processing. As previously explained, the diffuser plate 77 is located on the stacked containers 25 before the stacked containers

and pallet 62 is loaded into the retort 112. The pouches which are contained within the containers 25 are thereby treated, and water from the retort is able to flow through the open top of the containers 25, over the pouches and out through the open bottom so the water flows down through the stack of containers and over all of the pouches to properly treat the pouches. After the product in the pouches 1 has been sterilised in the retort 112, the pallet 62 is removed from the retort 112 and moved to a packaging station 114 where the pouches are removed from the containers 25 and packed in cardboard boxes for distribution. Thus, this embodiment of the invention enables the pouches to be conveniently and easily handled after the pouches are filled and sealed so that the pouches can be further treated in the retort 112 and then moved to the packaging station for packaging.

Figure 16 shows receiving end 104' of the supply conveyor 104. A trolley support 116 is fixed to the floor at the end of the conveyor 104 so the trolley 120 can be rolled up the support 116 and located at the end of the conveyor 104 so the pallet can be moved from the trolley and onto the conveyor 104. As is best shown in Figures 16 and 20, the trolley 120 comprises box section wheel supports 121 from which wheels 123 are suspended by brackets 123a. The box section supports 112 also support cross frame members 122 and 124 and longitudinal roller guides 125. As best shown in Figure 20, the guides 125 comprise a first beam 127 and a second beam 129 between which rollers 131 are journalled on axles 133.

The frame member 122 carries a plate 139 which has an opening 141. As is most clearly seen in Figure 22, a catch 143 passes through the opening 149 and is pivotally mounted between blocks 144 fixed to the plate 139 on pin 145. One end of the catch 143 is biased downwardly by spring 147 which is connected between the catch 143 and lug 149 fixed to the plate 139. The other end of the catch 143 has an abutment surface 150. The

catch 143 also has an unlocking lever 152 fixed to the end of the catch 143 which is connected to spring 147.

When a pallet is rolled onto the trolley 20 on the rollers 133, frame member 65' (see Figure 11) at one end of the pallet 62 will engage abutment surface 150 of the catch 143 and will push the catch 143 downwardly in Figure 22, as shown by Arrow A, so that the catch 143 pivots about pivot pin 145 against the bias of the spring 147. This will allow the frame section 65' of the pallet to pass over the catch 143 and locate behind the abutment surface 150. As soon as the frame section passes over the abutment surface 150, the catch 143 is able to pivot back into the position shown in Figure 22 due to the bias of the spring 147 so that the abutment surface 150 is trapped behind the frame member 65' of the pallet to thereby securely lock the pallet onto the trolley. The rollers 133 are received in the grooves 73 so that the trolley is held against lateral movement to further facilitate secure loading of the pallet onto the trolley 120. Whenever it is desired to release the pallet from the trolley so the pallet can be rolled off the trolley onto the conveyor 104, the handle 152 is pivoted in the direction of Arrow B in Figure 22 to pivot the catch 143 about the pivot pin 145 to remove the abutment surface 150 out of alignment with the frame section of the trolley so the frame section 65' is free and the pallet can be rolled off the trolley 120 on the rollers 133 and onto the conveyor 104.

The support 116 is designed to raise the trolley to the required level so that the pallet will be at the exact height for rolling onto the conveyor 104 with the groove 73 registering with chains 140 of the conveyor 104. When the chains are moved, as will be described hereinafter, the pallet is therefore conveyed along the conveyor 104 to the unloading station 104'' described with reference to Figure 15.

The support 116 is best shown in Figures 17 to 19 and comprises a pair of channel sections 141 and 142 which

have an enlarged open end 143 which tapers to a more narrow section 145. The channel sections 141 and 142 are supported on legs 146 which are designed to ensure that the trolley 120, when loaded onto the support 116, is at the height of the conveyor 104 (or the conveyor 106) as previously described. The support 116 includes a wheel lock 148 for securely holding the trolley 120 on the support 116 during unloading of a pallet from the trolley 120 (and reloading of the pallet from conveyor 106 onto the trolley). As best shown in Figure 18, the wheel lock 148 comprises a bar 149 which passes beneath the tracks 141 and 142 in guide sleeves 150. The bar 149 carries an L-shaped lug 153 and an L-shaped lug 154. The lug 154 has an upstanding handle connected to it to facilitate movement of the bar 149 in the direction of double headed arrow C in Figure 18. As can best be seen in Figure 18, the channels 141 and 142 have side walls 155, and the side walls 155 are provided with cut outs 157 in the vicinity of the L-shaped lugs 153 and 154. When a trolley 120 is rolled up onto the support 116, as is shown in Figure 18, the bar 149 is pulled all the way to the right in Figure 18 so that the lugs 153 and 154 are clear of the channels 141 and 142 to enable the wheel 123 to be moved all the way to the end of the channels 141 and 142. The bar 149 is then pushed to the left in Figure 18 so the bar slides in the sleeves 150 and the L-shaped lugs 157 pass through the cut outs 157, as is shown in Figure 19, and locate behind the front wheels 123 of the trolley 120. Thus, the trolley 120 is securely locked in place at the end of the conveyor 104 to facilitate movement of a pallet from the trolley 120 onto the conveyor 104. The trolley is unlocked simply by moving the bar 149 to the right in Figure 18 so the L-shaped lugs 153 and 154 are moved away from the wheels 121, and the trolley can be rolled on the channels 141 and 142, and off the support 116. A support identical to the support 116 is also located at the end of the conveyor 106 for locating a trolley 120 onto which

stacked pallets 62 are to be loaded after the pallets are conveyed from the station 106'' to the ends 106' of the discharge conveyor 106. As previously described, the stack conveyor which carries containers 25 loaded with pouches one can then be manoeuvred on the trolley to the retort 112 so the pouches are treated in the retort 112 and, after treatment in the retort 112, the pallets can be moved on the trolley to packing station 114.

Figures 14A, 14B, 14C, 14D and 14E show a container according to another embodiment of the invention. In this embodiment, the container 25' is formed from a plurality of container modules 25''.

Each module 25'' has a base 800 and a pair of upstanding pouch support elements 801 which include the aligned slots 50 which are configured in the same manner as shown in Figures 9 and 10.

As is best shown in Figure 14C, the bases 25'' have a hole 803 so water can drain through the container in the manner previously described.

Each of the modules 25' is provided with a first bore 807 which passes through the base 25'' of the module in a first direction, and a second bore 808 which is arranged slightly above or below the bore 807 and which passes through the bases 25' in a direction perpendicular to the bores 807.

A container of a predetermined size can be formed from the modules by locating the modules together so as to form a desired configuration of pouch carrying pockets (which, in the example shown in Figure 14A is three wide and ten long). However, the configuration can be changed to suit the size of the pouch 1 and also to maintain the container within a predetermined size for easy collection by the lifting mechanism. For example, if the pouch 1 is a large pouch, then fewer modules are used to make up the brick, thereby providing a brick of the same size as previously described, but which carries fewer pouches. If the pouches are small, a larger number of modules can be

connected together to form a container of the same size which will carry a larger number of pouches 1.

Figure 14E shows how the modules 25' are connected together. When the modules are located in the desired configuration and in side-by-side position, the bores 807 of each module are in alignment to form a continuous channel through the modules and the bores 808 are also in alignment also to form a continuous channel through the modules. Rods 810 are located through each of the aligned bores 808 which make up a continuous channel through the container. Similarly, rods (not shown) are located through the aligned bores 807 which make the further continuous channel in the direction perpendicular to the bores 808. The rods 810 (and also the rods which will pass through the bores 807) may include screw threaded end 811 onto which a nut 812 is screwed, thereby retaining the rod 810 through the aligned bores to connect the modules together. Alternatively, one end of the rod 808 may be provided with a rod head which is fixed to the rod, rather than being provided with a screw threaded end for receiving a nut 812.

It should be understood that, whilst not shown in Figures 14A to 14D, the corners of the container are provided with upstanding pillars or walls which carry the blocks 44 and pins 46 to enable containers 25' to be stacked one above the other. Thus, special corner modules which include these pillars may be provided which will always form the corner modules of a formed container. Those modules will also include the hole 47 in which the pins 46 locate.

The container of Figures 14A to 14D may include slide pads on the underside of the bases 25' and is intended to roll on a conveyor system in order to be transported about the plant, as will be described in more detail with reference to Figure 15A.

Figure 23 is a plan view of part of the filling and heat sealing line shown in Figure 15 and Figure 24 is

a side view of the line. Filled and sealed pouches 1 are delivered from the heat sealing station 92 in Figure 15 to cooling station 94, which is known and therefore will not be further described. After the pouches have been heat sealed, they drop from the heat seal station 92 from the mechanism which conveys the pouches through the filling station 90 and to the heat sealing station 92 to a pouch carrying system 200 which moves the pouches through the cooling station 94, the pressing station 96, the vision system 98, the reject station 100 to the pouch loading station 102. As can be best seen in Figure 24, as the pouches leave the heat sealing station 92, they drop under the influence of gravity onto the mechanism 200. The system 200 comprises a bar 201 which has a plurality of fingers 202 which extend perpendicular to the bar 201. As is best shown in Figure 24, the fingers 202 are spaced apart from one another so as to define pairs of spaces S1 which are separated by spaces S2 which are of shorter length than the spaces S1. The spaces S1 receive the pouches 1 and the spaces S2 are left blank so that the pouches 1 are moved through the system in pairs, as is shown in Figure 25. The beam 201 is pivotally connected to a plate 203 by a pair of links 204 and a pair of links 205. The links 205 are connected at respective opposite ends to the beam 201 and the plate 203 by pivot pins 206 and 208 respectively. A ram 210 is mounted on the plate 203 and has a ram arm 211. The ram arm 211 is pivotally connected to a link plate 213. The link plate 213 is pivotally connected to a U-shaped bracket 214 by a pivot pin 215. Retracted by the cylinder 210, the plate 213 pivots in the direction of Arrow D which pulls the bar 201 in the direction of Arrow E so that it overlaps the plate 213. This movement will withdraw the fingers 202 away from the pouches 1 which are supported on a guide surface 215 (see Figure 23) on which the pouches 1 can slide as the pouches are moved by the mechanism 200. When the ram arm 211 is extended, the plate 213 pivots in the direction

opposite Arrow D to push the bar 201 in the direction opposite Arrow E so the fingers 202 can engage a pair of pouches 1 with the pouches 1 being located between the fingers, as shown in Figure 25.

The plate 203 is connected to a chain conveyor which is driven by a sprocket and servo motor so that the entire mechanism shown in Figures 25 and 26 can be moved in the direction of Arrow F and then back in the direction of Arrow G. The sprocket and servo motor arrangement which drives the plate 203 back and forward in the direction of Arrows F and G is the same as the mechanism to be described with reference to Figure 37 which moves the carriage 400 in reciprocating fashion. This reciprocating movement of the bar 201 and the inward and outward movement of the bar 201 in the direction of Arrow E and the direction opposite Arrow E, will cause the bar to index the pouches 1 along the line towards the loading station 102 shown in Figure 15. That is, the sequence of operation of the mechanism 200 is that the chain conveyor will index the entire mechanism in the direction of Arrow G a distance equivalent to a multiple of the space between the finger 202' and 202'' in Figure 25. This movement will cause the pouches 1 retained within the spaces S1 to be moved in the direction of Arrow G by that distance. After that initial movement, the ram arm 210 is retracted so as to pull the bar 201 and the fingers 202 in the direction of Arrow E so they disengage from the pouches 1. The chain conveyor and stepper motor then moves the entire mechanism 200 in the direction of Arrow F so the pouches 1 shown in the left of Figure 25 are then aligned with another group of spaces S1, such as those labelled S1' in Figure 25. The ram arm 210 is then extended so that the bar 201 and the fingers 202 move in the direction of Arrow E so that the spaces S1 and S2 register with another pair of pouches 1, and the pouches 1 shown at the left in Figure 25 register with the spaces S1' in Figure 24. This sequence of operation continues so that the pouches 1 are

indexed along the line in the direction of Arrow G every time the bar 201 is moved in the direction of Arrow G.

As the pouches are indexed to the pressing station 96, a ram 220 is moved to push plate 221 inwardly towards plate 223 so as to squeeze the pouches 1 so the contents of the pouches 1 are compressed to spread the product in the pouches throughout the entire length of the pouch. In Figure 23, a pouch 1 is shown in a compressed position on the left hand part of the station 96, and on the right hand part is shown in an uncompressed position marked 1', and then in a compressed position 1. The compressed pouches 1 are then continued to be indexed in the direction of Arrow G as previously explained. The pouches then advance to the vision system 98 where the pouches are back lit by a back light 225, which may comprise a series of light-emitting diodes or any other suitable source of illumination, so that the light is transmitted through the pouches and the transparent strip 17 previously described, and is detected by cameras 230. The cameras 230 can then determine the integrity of the seal and generate a signal if the pouch is to be rejected. The reject station 100 comprises a pair of doors 226 (only one of which is shown) over which the pouches 1'' in Figure 23 are located. If those pouches have been determined to be faulty by the vision system 98, the door or doors 26 are opened and the pouch 1' drops through the door to a reject station. If the seal is properly formed, the doors 226 remain closed and the pouches simply move across the closed doors to the unloading station 102 as the pouches are indexed by movement of the bar 201 in the manner previously described.

As previously described, and as shown in more detail with reference to Figures 24 and 27, the loading station 102 is arranged above indexing mechanism 106. Pouches 1'' in Figure 26 are shown at the loading station 102. The loading station 102 is the same as the reject station 100 and comprises doors 227 which are opened in

sequence with the arrival of the pouches 1'' at the station 102. The pouches 1'' are therefore able to drop by gravity through the open doors 227 and into the containers 25 (not shown) which are being indexed by the mechanism 106 in the direction of Arrow H in Figure 27 past the loading station 102.

With reference to Figures 27 to 31, which show the indexing mechanism 106 in more detail, the mechanism comprises a pair of continuous chains 240 which are interconnected by abutment bars 241. The bars 241 are carried by the chains 240 as the chains circulate about sprockets 242 shown in Figure 29. Sprocket 242, at the right hand of Figure 29, is driven by stepper motor 243 so that the chain moves in indexing fashion in a direction of Arrow J in Figure 29.

With reference to Figure 29, a container labelled 25' is positioned in a carriage 400 (see Figure 32) by robot 105 which lifts the empty container 25' from pallet 62' shown in Figure 15, and deposits the container 25' in the carriage which is located at the right hand end of the indexing mechanism 106. The carriage includes a pair of clamps, schematically shown at 250 in Figure 29, which hold the container 25' so the container is moved with the carriage and is able to slide on tracks 252. The movement of the carriage in the direction of Arrow K is an indexing movement which is synchronised with the indexing movement of the chains 240. The carriage moves the container 25' to a drop station 255 at which the container 25'' is located. At that station, the clamps 250 are released so that the container 25' drops from the carriage and into the chains 240 between two adjacent bars 241. The guide 252 ends at the station 255 so it does not interfere with release and dropping of the container 25' at the drop station. The container 25'' is now located between the bars 241' shown in Figure 27, and indexing movement of the chains 240 in the direction of Arrow K will cause bar 241'' to contact the container and move the container

along with the chains 240 and bars 241. The container 25 rests on a pair of guide rails 257 so the container 25 can easily slide on the guide rails 257 as the container 25 is indexed by the bars 241. Thus, the containers 25 are indexed past the loading station 102 in sequence with the movement of the pouches 1 to the loading station 102. Each indexing step enables two pouches to drop through the doors 227 and deposit in the container 25 in the two pairs of aligned slots 50 previously described (see also Figure 24). Thus, the pouches 1 are dropped in pairs (such as the pairs P1 and P2 described with reference to Figure 9) into the container 25. After one pair of pouches 1 has been dropped into the slots 50, the container 25 is indexed at a distance equivalent to the space between that pair of slots and the next pair of slots 50, and the doors 27 again opened to enable another pair of pouches 1 to drop into that pair of slots 50. This indexing movement continues until the container is completely full. As shown in Figure 29, containers 25 are continually loaded into the carriage and then onto the chain 240 for indexing movement past the station 102 so that pouches are loaded into all of the containers.

The loaded containers 25 eventually reach a lifting station 260 which is occupied by the container 25''' in Figure 29. That station includes a ram 261 which carries a plate 262. When the ram 261 is actuated, the plate 262 rises so as to lift the container 25'' out from between the adjacent bars 241 and above the chain 240. A receiving carriage 402 (Figure 34) which is basically the same as the previously mentioned carriage, is located at the station 260 and the container 25''' is pushed up into that carriage. The receiving carriage includes clamps similar to the clamps 250 and those clamps engage the container 25''' after it has been lifted by the ram 261 so that the container 25''' is securely held in the carriage 402. The ram 261 is then lowered to return the plate 262 to the position shown in Figure 29. The receiving

carriage then moves the container 25 to a collection station 270 which is occupied by the container 25'''' shown in Figure 29. After the container 25''' has been engaged by the receiving carriage and commences to move, the container 25'''' slides on guide rails 263. When the container reaches the station 270, the clamps of the receiving carriage are released, and the robot 105 engages that container and moves the container from the receiving carriage and stacks it on a pallet at the stacking station 106'' shown in Figure 15. Thus, the loaded containers are stacked on a pallet (such as the pallet 62a shown in Figure 15) and when the pallet is full, the pallet 62a is moved to end 106' of the discharge conveyor 106 shown in Figure 15 in the manner previously described.

Figures 32 to 38 show more detail of the indexing mechanism 106, and in particular, the carriages 402. With reference to those figures, and in particular Figures 32 and 36, the carriage 400 has a rear wall portion 403 and side wall portions 404 and 405 so the carriage forms a square U-shaped configuration. Figure 36 omits much of the wall structure 403, 404 and 405, so the clamps 250, which are contained within the wall structures 404 and 405, can be clearly seen. As shown in Figure 36, the carriage has a pair of flanges 407 which have U-shaped channels 408 and which receive rails 409 of a linear bearing 410. The linear bearing 410 is completed by a rail 411 on which the rail 409 sits. The flange 407, on the right of Figure 36, has an extending plate 412 which carries clamp plates 413 and 417 which are clamped onto a belt 415 by bolts 416.

The linear bearings 410 are mounted on frame portion 414 of the indexing mechanism 106 which is arranged above the indexing chain 240.

The clamps 250 comprise a clamp plate 420 and a ram 421. The plate 420 is connected to ram arm 422 of the ram 421. Thus, when the ram arm 422 is extended, the clamp plate engages the sides of the container 25 to

securely hold the container 25 in the carriage 400, and when retracted, allow the container 25 to drop from the carriage 400 into the space between two bars 241 carried by the indexing chains 240, as has previously been described.

The plate 412 and the belt 415 are contained within a housing 431 (only shown in Figure 36), but omitted from Figure 32 for ease of illustration. The plate 412 is able to move through a slot in the housing 431 to accommodate movement of the carriage 400, as will be described hereinafter.

The carriage 400, as is shown in Figure 32, is initially at the end of the indexing mechanism 106 and receives the container 25 from the robot 105, as previously described. The carriage 400 is then indexed by movement of the belt 415 so the carriage slides on the rail 411 of the linear bearing 410.

Figure 37 shows a servo motor 440 which drives the belt 415 to move the carriage 400. As can be seen in Figure 37, the belt 415 extends around pulleys 441, 442 and 443, and moves the carriage in the direction of Arrow S in Figure 37 to advance the container 25 to the dropping station previously described. The movement of the carriage in the direction of Arrow S is an indexing movement which is synchronised with the indexing movement of the chain 242 so that when the container 25 arrives at the dropping station, the container 25 can be released by disengaging the clamp 250, as previously described, so the container 25 drops to the position shown in Figure 37, and labelled 25a, between two of the bars 241 carried by the chain 240. The container 25a is then continued to be indexed by the chain 240 past the loading station 102, previously described. The motor 440 then reverses direction and quickly moves the carriage 400 back in the direction opposite Arrow S to the position shown in Figure 32, ready to receive another container 25 from the robot 105.

As previously described, the container 25 is indexed by the belt 240 and the bars 241 to the collection station where the carriage 402 collects the container 25, as is shown in Figure 34. As previously described, the ram 261 is activated to raise the container 25 up into the carriage 402 which is ready waiting in the position shown in Figure 34 in registry with the ram 261, and plate 262. When the container 25 is received in the carriage 402, the clamps 250 of the carriage 402 are operated to engage the container 25 so the ram 261 can be retracted, and then the carriage 402 is moved from the position shown in Figure 34 to the position shown in Figure 35 by a belt 415 and motor 440, which are exactly the same as the assembly previously described, and which is shown in Figure 38.

When the container 25 has been moved to the position shown in Figure 35, the container 25 is ready for stacking by the robot 105 and once the container 25 is removed from the carriage 402, the carriage 402 moves back to the position shown in Figure 34 ready to receive the next container 25 when the container 25 reaches the ram 261 and the plate 262.

The carriages 400 and 402 may include sensors for detecting when a container 25 is loaded in the carriage to provide a signal indicative of the presence of a container to facilitate sequence of movement of the carriages 400 and 402 in the indexing mechanism 106.

Figure 39 shows the sequence of movement of the robot 105. As can be seen in Figure 39, the robot lifts a container 25 from the unloading station 104 on the conveyor 104 and moves the container 25 to the carriage 400. The robot then deposits the container 25 in the carriage 400, and the carriage then moves, as previously described, to locate the container 25 on the indexing chains 240 and their associated bars 241. The container 25 is then indexed by the chains 240 to the loading station 102 where the pouches are loaded into the containers. As soon as the container 25 has left the

carriage 400, the carriage 400 is returned to its initial position and a new container 25 is loaded by the robot 105. The robot 105 may load three or more containers in this fashion before a fully loaded container is ready at the receiving station 270 where the robot lifts the container 25 from the carriage 402 and stacks the container 25 on pallet 62 at the stacking station 106''. As is apparent from Figure 39, the pallet moving conveyor 110 passes under the robot 105 which can be mounted on suitable frame supports to straddle the pallet moving conveyor 110.

Figure 40 is a detailed view of head 105a of the robot 105 which shows how a container 25 is engaged and lifted by the robot 105. The head 105 has a pair of catches 450 and 451 which are moved by rams (not shown) carried by the head 105a. As shown in Figure 40, the catches 450 can move between the position in which the catches 450 engage beneath blocks 44 on the container 25 so the container 25 can be lifted and then can be pivoted out of engagement with the blocks 44, as shown by reference numeral 450', so the container 25 is released. The rams which control the catches 450 are controlled by the robot software which controls movement and sequencing of the robot, to perform the manoeuvres previously described.

Figures 41 and 42 show a detailed cross sectional view of the doors 227 which are arranged at the loading station 102 and which are also identical to the doors at the reject station 100 which reject faulty pouches. Thus, only the doors 227 and their mode of operation need be described.

As shown in Figure 41, the doors 227 are pivoted on pivot pins 460 and 461 to part of the filling line frame (not shown). A pneumatic ram 462 is provided and has a ram arm 463 which is pivotally connected to an upstanding link 464. The link 464 is connected to a link 465 by pivot pins 466 and to one of the doors 227 by pivot

pin 466. As shown in Figure 41, the link 465 connects to the upstanding link 464 at a mid portion of that link. The upper portion of link 464 is pivotally connected to a link 470 by a pivot pin 471. The other end of the link 470 is pivotally connected to the other door 227 by pivot pin 472.

When the arm 463 is retracted, as shown in Figure 41, the doors 227 are closed and a pouch 1 is able to rest above flange portions 480 of the doors 227. When the ram 462 is activated to extend the ram arm 463, the links 464, 465 and 470 pivot into the position shown in Figure 42 which causes the doors 227 to pivot downwardly, as shown in Figure 42, so that the flanges 480 are removed from beneath the pouch 1 and the pouch is able to drop under the influence of gravity through the doors 227. It is then deposited in one of the containers, as previously described. The ram arm 463 is then retracted to close the door 227 to await the next pouch and an appropriate signal from the indexing mechanism and system controller to again open the doors 227 to allow that pouch to drop into the next pair of slots 50 of a container 25.

Figure 43 is a side view of the supply conveyor shown in Figure 15 in the direction of Arrow X in that figure. The conveyor 104 includes a first chain conveyor section 270, a second identical chain conveyor section 271, and a third chain conveyor section 272 which forms the unloading station 104''. The section 272 also carries a subassembly 273 which in turn supports a roller conveyor which forms part of the pallet moving conveyor 110 shown in Figure 15. The conveyor sections 271 comprise the continuous chains 104 which circulate about sprockets 274. One of the sprockets 274 is driven from a motor 275 via a chain 276. The sections 270, 271 are supported in a frame 275, which is only partly shown for ease of illustration.

Figures 44, 45 and 46 show the sections 270, 271 and 272 in more detail, and if laid side by side, would show the complete supply conveyor 104.

The section 272 will be described in more detail with reference to Figure 44. The section 270 comprises a pair of chains 280 (only one of which is shown) which circulate about sprockets 281 and 282. The sprockets 281 and 282 are journalled on shafts. Drive is supplied to one of the sprockets 281 from a motor 283 via sprocket 284 connected to the output shaft of the motor 283 and chain 285.

The section 272 includes an end abutment 286 against which pallet 62 can engage to properly locate the pallet at the end of the section 272 and properly at the unloading station 104'', previously described. A pivotally mounted finger, which is mounted on pivot pin 288, is provided for engaging the opposite end of the pallet 62 to that which abuts the abutment 286 so the pallet 62 is properly locked and securely held in position at the loading station 104'' for unloading by the robot 105. This ensures that the pallet 62 and the containers 25, which are stacked on the pallet, are in a known position so the robot can, due to prior programming, know exactly where each container is, and therefore move to each container in sequence and lift the container from the pallet 62 and load the container into the carriage, previously described.

As is best shown in Figures 47 and 48, the finger 287 has one end pivotally connected to ram arm 289 of a ram 290. The finger 287 is usually in a retracted position, as shown in Figure 48, in which the ram arm 289 is extended and therefore the finger 287 is pivoted around pivot pin 288 into the retracted position shown in Figure 48. When the pallet 62 has moved onto the conveyor section 272 and abutted against abutment 286, the ram arm 287 is retracted to pivot the finger 287 in the direction of Arrow L in Figure 48 so as to position the finger in the position shown in Figure 36 at which it engages the opposite end of the pallet to securely hold the pallet as previously described.

The chain conveyor section 272 which forms the unloading station 104'' also carries the subassembly, 273 previously described. The subassembly 273 is also shown in Figure 38. It should be understood that the conveyor section 272 is shown from the direction of Arrows X in Figure 15, in Figure 44, and from the direction of Arrows Y in Figure 15, in Figure 49. The chain 280 and its associated sprockets etc, are not fully shown in Figure 49 for ease of illustration, although Figure 49 does show parts of the chain 280 located in the groove 73, the pallet 62.

The subassembly 273 comprises opposite frame sections 290 (only one of which is shown) and only one of which can be seen in Figure 44 for ease of illustration. Each frame section 290 is joined by a cross frame member, and each frame section 290 journals one end of a plurality of axles 291.

The frame sections 290 sit on curved frame supports 293 which form part of the frame 275 of the conveyor section 272. A ram 294 is fixed to the frame 275 and has a ram arm 295. The ram arm 95 is connected to a bar 296 by a pivot connection 297. The bar 296 is connected to a pair of cross bars 299 (only one shown in Figure 44) for pivotal movement relative to the bar 296. The bars 299 each carry a pivotally mounted lever 300. Each lever 300 is connected to a bar 301 and the bars 301 each carry at their ends lever arms 302.

Thus, when the ram arm 295 is moved in the direction of Arrow N in Figure 49, the bar 296 is moved in the same direction and the levers 300 pivot with bar 301 in the direction of Arrow Q in Figure 38. This pivots the lever arm 302 in the same direction because those lever arms are fixed onto the bars 301, and this pushes the frames 290 carrying the axles 291 upwardly in the direction of Arrow R in Figure 49.

As is best shown in Figure 44, the axles 291 carry a pair of rollers 305 which register with the slots

75 on the underside of the pallet 62. Movement of the frame 290 upwardly in the direction of Arrow R will locate the rollers 305 in the slot 75 and will lift the pallet 62 upwardly with the frame 290 so that the pallet 62 is lifted off the chains 280 and above the chains 280, and rests on the rollers 305 which are mounted on the axles 291.

Upward movement of the frame 290 is guided by slots 306 in the frame which receives a pin 307 which is fixed to the frame 275. Thus, the engagement of the pin 307 in the slot 306 restrains the frame 290 and therefore the subassembly 273 for vertical movement relative to the remainder of the conveyor section 272 so the rollers 305 do move vertically upwardly and engage in the slots 75 in the underside of the pallet 62.

When the rollers 305 have been engaged in the slots 75, the pallet 62 is able to roll on the rollers into the plane of the paper in Figure 44 or to the right in Figure 49.

The axles 291, and therefore the rollers 305, are driven by a motor (not shown) which drives shaft 308. The shaft 308 has sprockets 309 connected to it and the axle 291 has sprockets 310. Chains 311 extend around the sprockets 309 and 310 so drive is transmitted from the motor and shaft 308 to the axle 291. Additional chains and sprockets can be connected between the remaining axles 291 so each of the axles 291, and therefore the rollers 305 carried by those axles, are also driven. Obviously, when the axles 291 are driven and the rollers 305 are in engagement with the pallet 62, the pallet is driven along the rollers which forms part of the pallet moving conveyor 110, previously described with reference to Figure 15.

Figure 50 is a view of the pallet moving conveyor 110 from the direction of Arrows Y in Figure 15.

The moving conveyor 110 comprises the section 272, previously described, and in particular, the subassembly 273 which carries the roller conveyor

previously described, a central conveyor section 320, and a second conveyor section 272' which is identical in structure to the conveyor section 272. The section 272' forms the stacking station 106'' of the discharge conveyor 106. The second 272, in terms of the subassembly 273, is structured exactly the same as the subassembly in the section 272 except that in this embodiment the subassembly 273 is initially held in the raised position so that a pallet 62, which has been driven off the section 272 and onto the section 320, can then be driven onto the section 273 by the rollers 305. Until the pallet abuts end abutment 321. At this stage, the ram 294 is activated to lower the subassembly 273 and therefore the roller conveyor formed by the roller 305, so that the pallet 62 is lowered onto the chains of the conveyor section 272' so those chains register in the grooves 73 on the underneath side of the pallet 62. The pallet 62 is locked in position on the section 272' by fingers 287, identical to those previously described, so the pallet is securely and accurately located on the section 272' so that loaded containers 25 can then be stacked on the pallet 62. After the pallet has been stacked, the loaded pallet 62 can be moved on the chains of the section 272' and along the conveyor 106 to discharge end 106' as has been previously described. Thus, the section 272' forms part of the pallet moving conveyor 110 and also part of the discharge conveyor 106.

The mid section 320 of the moving conveyor 110 is shown in more detail in Figure 51 and includes sprockets 329 about which continuous chains 331 extend. It should be noted only one chain 331 is shown in Figure 51. The chains 331 engage in the grooves 73 as previously described. The chain 331 is driven by a motor 332 via sprocket 333 and chain 334 which engages with a sprocket (not shown) mounted on a common shaft 336 to which the sprockets 330 at the left hand end of Figure 50 are mounted.

The discharge conveyor 106 is shown in Figures 52 and 53, and includes the section 272' previously described, and section 330 which is the same as the sections 270 and 271 of the supply conveyor 104, previously described. The discharge conveyor 106 is completed by a roller conveyor section 340 which mounts a plurality of rollers 341 which are provided on axles 350 and which engage in the grooves 73 in the underside of the pallet 62 as the pallet moves from the section 330 onto the rollers 341. The rollers 341 are idler rollers and are driven so that the pallet 62 is moved manually or under the influence of gravity when on the section 340.

As best seen in Figure 53, the section 340 includes support bars 342 which extend between frame portions 343. The frame portions 343 include two beams 344, between which the respective axles 350 are mounted, to in turn mount the rollers 341.

Figure 15A is a plan view of a plant according to a second embodiment. Like reference numerals indicate like parts to those described with reference to Figure 15. The embodiment of Figure 15A is specifically concerned with the packaging of hot liquids such as fruit juice which has been pasteurised. The liquid is filled into pouches which are sealed and inspected in the vision system 98 in a similar manner to that previously described. The loading station 102 receives the pouches and loads the pouches into the containers 25'' previously described. The containers 25'' are then moved onto a continuous conveyor system 900 which forms the transporter for transporting stacked containers through the plant to packaging. In this embodiment, the containers firstly move on the container 900 through a container cooling station 901 which cools the heated pouches which have had heated liquid located in them. The containers then move on the conveyor to a drying station 902 where the containers are dried. The containers are then indexed from the conveyor 900 to an accumulator which simply is a

conveyor system which enables containers to be accumulated or stockpiled so that if there is a breakdown in the plant downstream, the filling and heat sealing can continue with the containers being stockpiled at the accumulator 95, or if the heat sealing line should stop, there will be a supply of containers at the accumulator 95 which can be continued to be supplied for packaging. The full containers can then be unloaded at an unloading station 908 by a robot 105 similar to that previously described, and the empty containers conveyed back on a conveyor system 110 to the container loading station 102 in a similar manner to that previously described. Cardboard boxes or cases are assembled at a case erector 912 and loaded onto a conveyor 913 and the pouches are unloaded from the containers by the robot 105 and are placed in the formed cases. The cases are then conveyed to a case sealer 915 where the cases are sealed and loaded onto pallets at station 920 by a robot 930.

Thus, in this embodiment, rather than transport the stacked containers 25 on a pallet as in the previous embodiment, the stacked containers are transported by way of a conveyor belt system through the plant for further processing and then for eventual packaging into boxes or cases.

As previously explained, vision system 98 monitors the integrity of the heat seals formed on the pouches and rejects pouches if the heat seal is not properly formed. The vision system comprises cameras 230 which are mounted in suitable camera houses and UV light source 225. The pouches 1 are moved relative to the cameras 230 and UV light source 225, such that the transparent strip 13, previously described, faces the light source 225 so ultraviolet light is directed from the light source 225 to the strip 13, as explained with reference to Figures 1D and 1E. The cameras 230 and light source 225 are mounted in a separate frame assembly (not shown) to the remainder of the heat seal and filling line

so that vibrations which are present in the heat sealing and filling line are not imparted to the cameras 230 or back light 225. As the pouches pass the cameras 230, an image of the pouches is obtained from the light which is transmitted through the pouches from the back light 225, as is previously explained. The seal region of the pouches 1 is identified by using the notches 21, previously described, which form a reference point. Thus, the control software which may be fully contained within the cameras 230 themselves, or which may be separate from the cameras, locate the notches 21 and when found, have positioned the transparent strip 13 because the transparent strip 13 will always be located in a fixed position relative to the notches 21. Thus, the inspection region of interest is therefore identified and now can be processed to determine whether the seal is properly formed.

The control software compares the intensity of light received by each pixel in the inspection area of the camera with a grey scale which runs from 0 which is indicative of white light to 255, indicative of no light at all, or in other words "black light". If the seal is properly formed, the intensity of the light detected by the pixels of the cameras 230 should be on the grey scale range of between 0 and, for example, 130. If the pixel identifies an intensity on the grey scale of above, for example, 150, this is indicative of some contaminant or other imperfection in the heat seal.

The vision system may be formed as an integral filling and heat sealing line, as previously described, although the vision system is preferably mechanically separate from the heat sealing line so as to not be subject to vibrations of the filling and heat sealing line. However, the vision system may be a totally separate unit which can be provided for an existing heat sealing line, or a stand-alone vision system which can be used to inspect sealed pouches after the pouches have been

filled or heated, or after they have gone through some other treatment, such as a retort or the like.

The vision system, if provided as a separate unit, operates in exactly the same manner as previously described and as will be described hereinafter. However, Figures 53A, 53B and 53C show a schematic view of a stand-alone system in which a housing 600 is provided with a generally central channel region 601. Cameras 230' are mounted in the housing 600 and a UV light source 225' is mounted opposite the cameras 230. The channel 601 includes a horizontal conveyor system 605 which has holder elements 606 (not shown) for holding pouches 1 and conveying the pouches past the cameras 230' and UV light source 225'.

The housing 600 may be supported on legs 607. The conveyor 605 extends beyond the housing 600, as best seen in Figures 53A and 53B and has a vertically-mounted roller or sprocket assembly 609 at one end and a similar sprocket assembly 611 at the other end. A motor is provided for driving at least one of the sprockets 609, 611 for circulating the conveyor 605. Pouches 1 may be dropped into the conveyor 605 in the same manner as previously described, by conveying the pouches to a position above the conveyor 605, as shown in Figure 53B, and releasing the pouches so they drop into the holder 606. In other embodiments, the pouches 1 could be fed in line to the conveyor 605 and collected by the holders 606 as the holders circulate.

The camera 230 is connected to a processor 610, which is schematically shown in Figure 53C. The processor 610 may be separate to the controller which controls the filling and heat sealing line, and which will be described with reference to Figure 54 or may simply be part of that controller. In any event, the processor 610 is in communication with the controller which operates the filling and heat sealing line so the reject system can be activated in the event that an improperly-formed seal is

detected and the vision system is used with the filling and heat sealing line.

If the vision system is a stand-alone system, the vision system may include its own reject station or reject pouches can be determined simply by visual inspection of a monitor driven by the processor 610, and defective pouches 1 manually or mechanically collected.

Figure 52A is a schematic diagram showing pixels P of the cameras 230 and a blob or imperfection in the seal 17 shown by the region 700. The bottom edge of the heat seal is also shown by the cross-hatched section 701. The gray value of the pixels outside the region 700 will be low because of the waveguide effect and transmission of the fluorescing light through the seal in the manner described with reference to Figures 1B to 1F, and as noted above, below 130. The pixels in the region 701 where no heat seal is formed, ie., a lower band to the heat seal, will obviously be high and much greater than 150 because they will see a dark band and the pixels in the region 700 will also have a high gray scale value because of the discontinuity of the waveguide formed by the blob or imperfection in the heat seal.

The next step in the software routine is to determine the size of the contaminant, and this is done by a blob extraction routine which determines the number of adjacent pixels which have a grey scale value of above 150. If only scattered single pixels have a grey scale value above 150, then this can be taken to indicate that there is no problem with the heat seal and the pouch is properly formed. However, if a number of adjacent pixels, for example 50 pixels, produce a grey scale value above 150, this is indicative of a contaminant of significant size being located in the heat seal which has destroyed the integrity of the heat seal, and therefore may allow air to enter the pouch, which would destroy the contents of the pouch. Thus, the grey scale reading for a number of pixels, such as 50, provides an indication that the

heat seal is not properly formed and that the pouch should therefore be rejected.

The control system or processor 610 (see Figure 53C) therefore outputs a signal to the controller to in turn cause the reject station 100 to be activated so the doors 226 of the reject station are opened in the manner previously described (in relation to the doors 227) so the pouch drops to the reject station under the influence of gravity through the open doors 226.

The processor 610 may also be programmed to determine whether a properly formed seal 17 is in existence by determining if there is a continuous band of a width of more than, for example, 3 mm, from one edge 7 of the pouch to the other edge 9, as previously described with reference to Figure 1G. Thus, the control system or processor 610 will determine if a path of that width can be formed around any region 700 and extend completely from one side of the pouch to the other which may be indicative of the fact that a properly formed seal is therefore present, notwithstanding the inclusion of region 700 in various parts of the seal. The width of the band obviously depends on the particular circumstances and the contents of the package.

Furthermore, the seal may also be regarded as improperly-formed even if such a band can be identified, but there is nevertheless region 700 which are of a size greater than a predetermined area. The reason for rejection may not be that this will enable air to enter the contents of the pouch, and may simply be that the seal is not regarded as aesthetically suitable, and therefore the package may be undesirable from a consumer's point of view, and therefore should be rejected. As previously described, the blob size of the region 700 can be determined by the number of adjacent pixels which are above a particular gray level and if the number of pixels exceeds the predetermined limit, the pouch can be rejected on the basis that the seal is not aesthetically pleasing

even though it may be satisfactory to safeguard the contents of the pouch.

Preferably, the cameras 230 are Cognex-in-sight 1000 made by Cognex Inc. of the United States of America, or cameras sold under the name Genius MX System made by Applied Vision LLC of the USA.

Figure 53E is a flowchart showing operation of the vision system of the preferred embodiment of the invention.

As previously described, the pouches 1 are transported along a defined path between the camera 230 and the lights 225. The camera to pouch distance is chosen to provide the maximum optical magnification of the seal area of the pouch, while allowing for some misplacement of the pouch by the handling mechanism. When a pouch 1 is moved into the inspection station of the vision system 98, an image acquisition trigger is sent from a programmable logic controller (described with reference to Figure 54) to the vision system 98. The camera 230 acquires an image of the seal area of the pouch and the image is digitised into a numerical form that can be manipulated by processor 610 to extract information relating to the image captured by the camera 230. The digitised image comprises a grey shade value of the pixels of the camera which make up the image in which black is represented by zero and white is represented by 255. This therefore produces a bitmap of the camera's field of view.

At step 1001 in Figure 53E, the digitised image is searched to locate landmark features to enable registration of the image relative to a predefined reference to be made. As previously mentioned, this can be done by identifying the notches in the pouch or a particular printed region of the pouch or other characteristic feature which is a known position relative to the intended seal can also be identified. This enables the seal area to be identified relative to that known datum, so that the bitmap which relates to the image of

the seal area can be further processed. Thus, at step 1002, the inspection zone is positioned relative to the landmark features.

If the vision system is not able to identify the landmark feature, the pouch is automatically rejected when it leaves the inspection station 98.

Mathematical rules or algorithms are programmed into the processor 610 during the design of the vision system or at initial setup to provide a process for evaluating the values in the bitmap and their relationship with each other.

At step 1003, the inspection algorithms are applied to the bitmap which will actually define the seal area relative to the landmark feature which has already been identified. Feature can be found by scanning the bitmap in a specific sequence commensurate with the shape of the object in the image to thereby search for changes in contrast in the bitmap. Changes in contrast occur where the light passing through or around the pouch seal is modified, as has been previously explained with reference to Figures 1A to 1I. The algorithms used in the inspection system allow the user to define a feature by adjusting parameters during the inspection setup to suit the specific application to which the vision system 98 is applied.

Overlapping inspection windows or zones are then placed across the seal area, ensuring a 100% coverage of the seal. Each inspection zone is scanned to detect lack of adhesion and/or contaminants between the panels which inhibit the transmission of light through the seal creating the dark regions which have been previously described with reference to Figures 1A to 1I. The inspection tools are chosen to detect these regions, measure them and compare them to user defined threshold values. For example, a determination can be made to see whether a predetermined number of adjacent pixels have a grey scale value below a predetermined level indicating a

dark region which is indicative of an improperly formed seal or blob in the seal area. The inspection tools also detect the sides of the pouch and the top and bottom edges of the seal, and measure the size, position and angle of the seal to determine whether they meet predetermined parameters. If the seals do not meet the predetermined parameters, they are then deemed to have failed as per step 1004 and are rejected. If the seals pass as per step 1005, then the pouches can pass for further processing.

The processor 610 also maintains an inspection record of the results to generate audible or visual alarms if acceptable reject levels are exceeded, as per step 1006.

Figure 54 is a schematic control diagram showing sensors which are used to monitor and facilitate the operation of the system described with reference to Figures 15 to 53. The system is controlled by a programmable logic controller 500. Each of the supply conveyor sections 270, 271 and 272 includes a sensor 501, 502 and 503 respectively for determining if a pallet 62 is on that section. Pallets are therefore able to be moved from the section 270 to the section 271 when the sensor 502 indicates that there is no pallet on the section 271. If this occurs, the motor 276 of the section 270 is activated to drive the pallet onto the section 271, as is the motor 276 activated so that the pallet is driven on the section 271 until detected by the sensor 502. If the section 272 does not have a pallet, then this is detected by the sensor 503 and the pallet is continued to be driven onto the section 272. Sensor 504 is associated with the section 320 of the moving conveyor 110 and determines whether a pallet is on that section. Sensors 505, 506 and 507 are associated with the section 272', 330 and 340 which make up the discharge conveyor 106. These sensors operate in the same manner as the sensors 501, 502 and 503 by determining whether a pallet is on the particular section and therefore enabling a pallet, if available on

the previous sensor and ready for movement, to be moved and advanced onto the next section.

Sensors 508 and 509 are associated with the clamp cylinders 290 of the sections 272 and 272' for determining whether those cylinders are extended or retracted, and thereby to determine whether the pallet 62 is clamped in position or available for movement. The motors to transfer a pallet 62 from those sections is therefore not operated until the cylinder is retracted and the finger 287 removed away from the pallet so the pallet can be moved. Sensors 510 and 511 are associated with the rams 294 associated with the sections 272 and 272' to determine whether the roller conveyor 305 is in the raised or lowered position ready to transfer a pallet to the pallet moving section 320, and then to the section 272' of the discharge conveyor 106. Sensor 512 is associated with a robot 105 and determines whether a container 25 is gripped and held by the head 105a of the robot. Sensor 513 is the sensor which is associated with the carriage 400 for determining whether the container has been deposited in the carriage, and sensor 514 is associated with the clamps 250 of the carriage 240 for determining whether those clamps are in the clamping position or release position.

Sensors 515 and 516 are associated with the loading station 102 and determine when pouches fall through the doors 227 and into the container 25.

Sensor 517 determines the position of the lifting ram 261 and the plate 262 and the sensor 518 is associated with the clamps 250 and the carriage 402 for determining whether those clamps are in the clamping position or the release position. Sensors 519, 520 and 521 are associated with the carriage 400 and determine the home position of the carriage and whether the carriage has over travelled or under travelled during movement of the carriage from the position at which the carriage receives the container 25 to the position at which the carriage releases the container 25 to the indexing chain 240.

Sensor 522 is associated with the indexing chain 240 and is used to determine the home position of the indexing chain 240 so the indexing chain 240 can be returned to a home position if needed.

The robot 105 is also controlled by the PLC 500 so that operation of he robot is sequenced with the movement of the pallets 62 and containers 25 through the system.